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PALEONTOLOGICAL MONOGRAPHS OF THE NATIONAL GEOLOGICAL SURVEYS

By Dr. HENRY FAIRFIELD OSBORN

SENIOR GEOLOGIST, U. S. GEOLOGICAL SURVEY

THE forthcoming issue of Monograph 55 by the U. S. Geological Survey renders opportune a review of the continued encouragement by our government of research in vertebrate paleontology since the establishment of the National Geological Surveys. Monographic description of the extinct mammalian and reptilian life is referred to in the preface of the forthcoming volumes as follows:

Joseph Leidy, Edward Drinker Cope and Othniel Charles Marsh, who successively served as members of U. S. government surveys of the west, were the founders of American vertebrate paleontology. Leidy's memoir of 1869, entitled "The Extinct Mammalian Fauna of Dakota and Nebraska, Including an Account of Some Allied Forms from Other Localities, Together with a Synopsis of the Mammalian Remains of North America," marked the end of the first period of exploration. Cope's great memoir of 1885, entitled "The Vertebrata of the Tertiary Formations of the West," marked the end of the second period of exploration.

Meanwhile the subject had become too broad to be comprehended in a single work.

Accordingly, Marsh, as vertebrate paleontologist of King's survey of fortieth parallel, planned a series of exhaustive monographs on special groups of extinct birds, reptiles and mammals which should treat in great detail the anatomical structure and form the basis of a systematic classification. For these monographs he carried out the most intensive field

explorations known to science and published a large number of preliminary papers which fairly revolutionized our knowledge of these and many other groups. In 1880 the Fortieth Parallel Survey under Clarence King published his monograph on the "Odontornithes, an Extinct Group of Birds of North America." In 1883 the U. S. Geological Survey published his paper entitled "Birds with Teeth," and in 1886 his monograph on "The Dinocerata, an Extinct Order of Gigantic Mammals." This was the first of the series of five monographs projected for publication by the U. S. Geological Survey on the Dinocerata, the Stegosauria, the Ceratopsia, the Sauropoda, the Brontotheridae. The monograph last indicated has developed into the present monograph 55 on the titanotheres, which covers a much broader field than that contemplated by Marsh for the monograph on the Brontotheridae.

For the monographs on the Ceratopsia and on the Brontotheridae field exploration on an unprecedented scale was begun by the U. S. Geological Survey under the direction of Marsh. For the four monographs on the Stegosauria, Sauropoda, Ceratopsia and Brontotheridae, 204 superb lithographic plates were completed under Marsh's direction. Altogether he had been engaged on this work nearly seventeen years when death interrupted his monumental labors on March 18, 1899. He left no manuscripts for either of these unpublished monographs, only a few penciled notes, unpublished wood engravings and typewritten keys to the lithographic plates.

PREPARATION OF MONOGRAPH 55

The first important step taken by Marsh in his series of contributions to our knowledge of this extinct family was the publication of his paper on "The Structure and Affinities of the Brontotheridae," published in 1874, based on the collections at Yale University. The second was his paper entitled "Principal Characters of the Brontotheridae," published in 1876. In the meantime he had made a geologic excursion to White River in South Dakota, in the vicinity of the Red Cloud Agency. This visit marks an interesting epoch in the history of paleontologic exploration for the titanotheres.

Late in the autumn of 1875 Marsh, accompanied by an escort from Fort Laramie to the Red Cloud Agency, went to the Badlands of Nebraska and Dakota. The consent of the Indians was deemed necessary to permit safe search for fossil bones in their country. This consent was obtained with difficulty, and after it had been obtained the Indians withheld their assistance. An account of Marsh's visit is given in a manuscript entitled "Sketches of the Life of Red Cloud," by Captain James H. Cook, of Agate, Nebraska, at that time serving as a scout for the U. S. Army. Captain Cook writes:

> It was in the autumn of 1875 that I first learned of the petrified bones of strange creatures that had once occupied the lands to the eastward of the agency. Two of Red Cloud's subchiefs, American Horse and Little Wound, took me to the lodge of Afraid of Horses, where I was shown a piece of bone, perfectly petrified, containing a molar tooth three inches or more in diameter. American Horse explained that the tooth had belonged to a "Thunder Horse" that had lived "away back" and that then this creature would sometimes come down to earth in thunderstorms and chase and kill buffalo.
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> His old people told stories of how on one occasion many, many years back, this big Thunder Horse had driven a herd of buffalo right into a camp of Lacota people during a bad thunderstorm, when these people were about to starve, and that they had killed many of these buffalo with their lances and arrows. The "Great Spirit" had sent the Thunder Horse to help them get food when it was needed most badly. This story was handed down from the time when the Indians had no horses.

It was this Indian tradition of the "big Thunder Horse" which suggested to Marsh the family name of Brontotheridae, derived from the Greek word *brontos,* thunder. The popular name Titanotheres is used in Monograph 55 in preference because Titanotherium was the first scientific name applied by Leidy to one of these animals.

The first collections made for this monograph were those brought together from Colorado and South Dakota, part of them under the direction of Marsh, for the Peabody Museum of Yale University. By far the greatest collection was that brought together by John Bell Hatcher for the Geological Survey, now preserved in the U. S. National Museum. Between 1870 and 1891 Marsh published fourteen papers on these collections. These papers relate more or less directly to the Brontotheridae; the last appeared in 1891 and contained descriptions of three new types from South Dakota—*Allops crassicornis, Brontops dispar* and *Brontotherium medium.*

On June 30, 1900, the director of the U. S. Geological Survey, Dr. Charles D. Walcott, appointed the present writer vertebrate paleontologist of the survey with the duty of continuing Marsh's work of completing the four unfinished monographs, namely, on the Stegosauria, the Ceratopsia, the Sauropoda and the Brontotheridae. The Ceratopsia was entrusted to Hatcher and Lull; the Stegosauria to Gilmore, while Osborn undertook the Sauropoda and the Brontotheridae.

The task of preparing Monograph 55, "The Titanotheres of Ancient Wyoming, Dakota and Nebraska," has been long and difficult. First, it proved necessary to reexplore the entire Eocene and

lower Oligocene series of rocks in Wyoming, Colorado and South Dakota, where the fossilized remains of titanotheres are found, both to determine precisely their geologic succession and to close up gaps in the stages of evolution; second, it proved necessary to examine and compare the titanotheres of these geologic epochs in all the museums of this country and in several museums abroad; third, it proved necessary, in order thoroughly to understand the titanotheres, to discover and to follow many side lines of investigation that have not hitherto been followed in vertebrate paleontology.

This work has been done with the aid of many specialists, foremost among whom is my junior colleague, Professor William K. Gregory, without whose intelligent and unremitting cooperation the monograph could never have been completed.

It is, perhaps, not too much to say that this work has transformed our knowledge of the early Tertiary geology of the Rocky Mountain basin region. First, the six life periods recognized by Marsh and his no less distinguished contemporary Edward Drinker Cope may now be replaced by sixteen life periods, which may be clearly defined and separated and certain of which may be more or less precisely correlated with life periods established for western Europe. Second, a much clearer notion has been gained of the changing geographic, physiographic, climatic and volcanic conditions in Wyoming and Dakota and of their influence on the migration and succession of forms of life. Third, the wholly new method of attack on problems of vertebrate paleontology has been developed; we seek to know the entire living animal, its musculature, its mode of locomotion and its feeding habits, in order to insure the complete restoration of the body. Fourth, the study of the many branches of this group has given the most convincing demonstration that evolution, even in any one geographic region, seldom moves along a single line of descent; more frequently it moves along many lines —it is polyphyletic; in other words, it radiates, following the principles of local adaptive radiation. Finally, the history of the titanothere family in its evolution from very small and relatively weak forms into titanic quadrupeds, second in size only to the elephants, has afforded us a unique opportunity to enlarge our previous knowledge of the actual modes of evolution as well as to revise our theories as to the causes of evolution and extinction.

OBITUARY

ARTHUR S. LOEVENHART

ON April 20 the ranks of the all too small group of workers in the field of experimental therapeutics were reduced by the death of Arthur Solomon Loevenhart, and a career energetically devoted to pure science, to therapeutic advancement and to the defense and promulgation of the highest medical ideals was brought to a close.

Arthur S. Loevenhart was born in Lexington, Kentucky, December 29, 1878. He grew up in his native city, and in the course of time attended the State College of Kentucky which is located there. His early educational history is illustrative of how little the progress of science depends upon magnificent buildings or upon elaborately equipped institutes, and of how much it depends upon those rare individuals who, having caught the spirit of science, devote their lives to the pursuit of knowledge. At that time the chair of chemistry was held by Professor J. H. Kastle. The remainder of the staff of the department consisted of only one student assistant, so that it was necessary for Professor Kastle to give three or four lectures a day, supplemented by laboratory work, in order to provide instruction in the various branches of chemistry. Nevertheless, this heavy burden of routine did not prevent him from continually contributing to chemical knowledge or from presenting the subject in such a way as to inspire students to investigate its problems. Into his classes there came the young Loevenhart. Professor Kastle quickly recognized in him a keen and resourceful pupil, and Loevenhart found a wise and sympathetic teacher. The association was most fruitful. Even before Loevenhart's graduation, which occurred before his twentieth year, they had finished a joint research on "The Oxidation of Formic Aldehyde by Hydrogen Peroxide."

In the following year they started their work on lipase. In the course of this work Loevenhart made the valuable suggestion that lipase might be capable of effecting the synthesis of fats from fatty acid and glycerine, and this led to the experimental synthesis of ethyl butyrate from ethyl alcohol and butyric acid. Thus the reversibility of enzyme action was for the first time established in a clean-cut manner, there being no complication such as in the previous instance of enzyme synthesis discovered by Croft Hill in which isomaltose, not maltose, was produced under the influence of yeast maltase, the isomaltose so produced not being again hydrolyzable by the maltase.

The years 1899–1903 were spent as a medical student at the Johns Hopkins University, but this experience did not in the least decrease Loevenhart's interest in chemical subjects. It merely served to widen his horizon; a vaster field was unfolded in

which his chemical knowledge could be put to good use. His interests and ideals naturally brought him into association with men like Professor Abel and Professor Howell, and he endeared himself to his teachers on account of his keen mind and lovable personality. During his undergraduate years he did research under their protecting encouragement and guidance, and so active was his participation that they soon came to look upon him rather as a colleague than as a student. He had his headquarters in the laboratory of Professor Abel and on graduation he was offered an assistantship in the department. There he remained for five years and his association with Professor Abel became the second great source of inspiration in his career. His teaching duties necessitated giving instruction in both physiological chemistry and pharmacology, as these two subjects were then combined in the same department, but it is apparent that his inclination turned more and more toward pharmacology because his promotion to an associate professorship was made in that subject instead of in physiological chemistry as in the previous years. His advancement was rapid and in 1908 he accepted the professorship of pharmacology at the University of Wisconsin.

When a medical student he published his now well-known theory of fat absorption, based on the reversibility of lipase action. Experimentally he found that lipase is present in the cells of the intestinal mucous membrane. Theoretically he postulated that the fat droplets found in these cells are formed by lipase synthesis from the saponified products absorbed from the intestine. Similarly, he supposed the storage and release of fats from tissue cells to be effected by the same enzyme, which is either fat-forming or fat-splitting according to the momentary concentration of the products of the reaction. The work on lipase was also continued in the following years. Further investigations were made on the remarkable inhibition of lipase by fluorides, which had been discovered by Kastle and Loevenhart; bile salts were demonstrated to have all the properties of a co-enzyme, and the ester-splitting enzymes of different organs were found to have individual peculiarities.

During his vacations as a medical student, he worked with Professor Kastle in Lexington; and the result of this collaboration was a series of papers on the mechanism of oxidation, a subject in which his interest never flagged throughout his life. His last publication, like his first, was on this subject. In one of his early independent contributions he suggested the use of benzoyl peroxide as an antiseptic.

Professor Loevenhart went to Wisconsin at the time of the organization of the first part of the Medical School and became a part of the young, enthusiastic faculty which directed the fortunes of the new institution and which provided by its close contact with the small classes an opportunity which I feel can not be equaled in the larger classes which now prevail, there, as elsewhere. The department of pharmacology was housed in an attic, but it was given a considerable number of facilities and, because of the splendid *esprit de corps* existing among the various departments, it was possible to carry on research in a most satisfactory manner.

Loevenhart's earlier scientific work at Wisconsin centered around the subject of oxidation. It was a continuation of the work started with Kastle, but from a new angle. The work with Kastle was concerned with the mechanism of oxidation, while the new work was directed toward the determination of the action of various substances and conditions on vital oxidation, and the finding of the relation of vital oxidation to functional activity.

The work on the mechanism of oxidation can be evaluated properly only against a background picturing the evolution of the ever-changing ideas on this subject, particularly as it applies to biological oxidation. It will, therefore, be possible at this time to make only a few brief statements concerning the contributions in this field. The analogy between organic peroxides and oxidases was given abundant experimental support; it was proposed that peroxidases are organic substances which react with hydrogen peroxide to form peroxides of a higher oxidation potential than the latter. Many points as to the nature and occurrence of catalase were also elucidated.

One of Loevenhart's earliest problems in the second group was that of the mechanism of stimulation of the medullary centers, particularly the respiratory center. He observed that substances which reduce oxidation cause, like anoxemia, stimulation of the center, provided the center is initially irritable and the change takes place with sufficient velocity. On the other hand, substances containing active oxygen, like sodium iodoxybenzoate, depress the center. He was therefore much impressed with the rôle played by oxidation in the control of respiration. Those who remember the notions held about respiration twenty years ago will recall that the theory which then enjoyed popularity was that respiration is controlled by carbon dioxide, and that oxygen-want affects it only secondarily through the general acidotic metabolism produced. The latter possibility Loevenhart precluded by demonstrating that the latent period of the effect of cyanides on the respiratory center corresponds with the circulation time from the point of injection to the center, there thus being no interval in which an intermediary metabolism could take place.

He then pointed the way directly to the solution of the matter by postulating that anoxemia, and substances affecting oxidation, modify the activity of the respiratory center through its own metabolism. He supposed that two sets of metabolic processes take place in the cells of the center, one aerobic in nature, the other anaerobic. The first type was conceived as being concerned with recuperative processes and was therefore labeled "R," while the second type was designated as an "A" process because it was believed to be immediately concerned with functional activity. Decrease of the possibility of the utilization of oxygen due to anoxemia or to drugs with a cyanide-like action would thus cause an increase of the "A" process and an increase of the cells' specialized activity; on the other hand, in the presence of plenty of oxygen the oxidative metabolism would predominate and the cells would rest. This theory has had an enormous influence in the development of the modern concepts of the respiratory center.

Much work was done on the changes which are brought about in animals kept for considerable periods of time at low oxygen pressures. The observations made in the experiments are of fundamental importance, because in showing the behavior in pure anoxemia they afford a picture which may be compared with that produced by drugs supposed to act through interference with the oxidative mechanism. Descriptions were given of the hyperplasia of the bone marrow, of the hydropic and hyaline degeneration which occurs in the parenchymatous organs, and of the metabolic changes, namely, an increased excretion of nitrogen and organic acids, and an extreme degree of acidosis which follows an initial alkalosis due to hyperventilation, and which is an important factor leading to death, as life can be prolonged by alkali administration.

Other phases of this field which were investigated were sodium cyanide as a clinical respiratory stimulant, and the decrease in the inflammatory action of mustard oil under the influence of oxidizing agents.

The entrance of the United States into the World War necessitated the immediate establishment of research units to investigate the problems of chemical warfare. The laboratories of the Medical School of the University of Wisconsin were very early turned into such a unit and Dr. Loevenhart entered into the work with his usual energy. In the early days of the investigation before the organization became perfected he, characteristically enough, took his turn in the night shifts when men were needed to watch the ventilation of the chambers and to record the symptoms of the animals.

The center of the research division of the Chemical Warfare Service was located at the American University at Washington. The organization was divided into sections and for the pharmacological section a man was sought in whom research capacity and a knowledge of medicine, physiology and toxicology was combined with the ability to cooperate with other sections and to gather together a staff of loyal coworkers. Logically enough, Dr. Loevenhart was called from Wisconsin for this purpose. Twenty-four hours after receiving the call he was in Washington.

There is no doubt that Dr. Loevenhart's experience in the Chemical Warfare Service greatly influenced his activities during the next decade. Having participated in the greatest cooperative research effort in the history of the country, he had seen the rapid progress which is attainable when chemists and pharmacologists work together, and he returned to Madison enthusiastic in his desire to utilize the benefits of such an organization in the field of therapeutics.

He outlined in considerable detail plans for the organization of a therapeutic institute. It was proposed to compensate the present marked lack of balance between the diagnostic and therapeutic aspects of medicine by directing the attention to problems which, when solved, would be capable of immediate application to the sick. An effort was to be made to bring at once into usefulness the many points now lying fallow in the immense accumulation of fundamental knowledge regarding disease. Existing therapeutic practice and the newer therapeutic researches were to be examined on a scale which would permit the gathering of statistics of real significance, so that when a result was announced it would be conclusive.

The institute was to be part of a university with a medical school and a university-controlled hospital, so that the facilities they afford would be available. It was not proposed to pile up more bricks and mortar behind which more workers could carry on research along existing lines, but rather to develop a new spirit within existing walls. The staff, made up of chemists, pharmacologists and clinicians (and at times others), was to be selected not only from the standpoint of ability but also from the standpoint of those attributes of character which would enable them to work with others in complete harmony. This staff was to cooperate with workers on the outside by providing competent men with ideas the opportunity of trying them out, and also by referring problems to those most capable of solving them, supplying them if necessary with financial and personal aid.

Had Dr. Loevenhart lived he would continually have strived to bring such an institution into existence, and it is a great misfortune that the realization of his ideal has been delayed by his death. During

his life the work at hand was in no way curtailed by the quest of the ideal. With outside aid received as the result of his own efforts the activity in his department was maintained on a scale far beyond that permitted by its own budget. Also, many of his researches would not have been possible without the cooperation of departments in other institutions.

Among the investigations which were carried on in the Chemical Warfare Service many were concerned with organic arsenic compounds, and it was natural that Dr. Loevenhart's interest in those substances should continue through the following years. Soon after his return to Wisconsin he started experiments on the treatment of syphilis. This is a problem which demands not only laboratory facilities but also the opportunity for the clinical testing of promising compounds. Fortunately, the latter was provided in a unique manner through a collaboration with the department of neuropsychiatry. At that time a number of new compounds had recently been synthesized at the Rockefeller Institute for Medical Research and the institute was kind enough to place a number of them at his disposal for study. One of them, tryparsamide, proved to have very striking merit in the treatment of neurosyphilis. Many of the patients treated with it were restored to their homes and to useful lives.

An intensive investigation was then started in order to determine the basis of this action. A consideration of related substances soon revealed the fact that the treatment of neurosyphilis is a very special problem in the field of therapeutics with organic arsenicals. It was found to be impossible to predict from any property revealed by experimentation whether or not a compound would be of value in the treatment of paresis. Neither the ability to penetrate into the central nervous system nor to produce symptoms referable to a toxic action upon it shed any light on the problem, nor was there any relation to the effectiveness against experimental trypanosomiasis or experimental syphilis. While the introduction of the drug was an outgrowth from the chemotherapeutic theory, its action was apparently in defiance of its tenets. The tryparsamide molecule was subjected to a most thorough analysis in the hope that its action could be connected with some part of its structure, but its remarkable therapeutic activity was lost or decreased with every change of the molecule, although strikingly enough one series of compounds, in which the side chain ended in an alcohol group instead of an amide group, had a higher chemotherapeutic index in trypanosomiasis. He therefore concluded that the therapeutic power of tryparsamide is a function of the molecule as a whole, and that its action is not to be explained primarily on the basis of its spirochaetocidal action, but rather as the result of an alteration of the response of the tissues in the presence of the spirochaete with a consequent disappearance of inflammatory infiltration and improvement of the nutrition of the cells. The destructive action on the optic tract of the group of drugs of which tryparsamide is an example was shown to be due primarily to the presence of an amino group in the para-position to the arsenic.

The other subjects which engaged his attention in recent years were the pharmacology of the nitrites, the body changes occurring in insomnia and fatigue, and the local anesthetics. In the case of the latter an investigation was made of the effectiveness of the members of two chemical series. One substance, the isopropyl homologue of procaine, was found to occupy a particularly favorable position as a surface anesthetic.

Dr. Loevenhart also kept up his interest in the subject of oxidation, and his final contribution was a remarkable observation made in some experiments suggested by his deliberations on this subject and by some observations, made a number of years previously, on the behavior of patients in psychopathic depression when stimulated by cyanide. He reasoned that substances decreasing the utilization of free oxygen should stimulate cerebral cells as well as those of the respiratory center, and by the same mechanism —the one which has been previously mentioned in connection with his work on respiration—and he planned his experiments accordingly. When sodium cyanide or, better, mixtures of carbon dioxide and oxygen in varying concentration were administered to patients in catatonic depression, there first occurred a short period of respiratory stimulation, then the catatonia passed off and for a short period the patients behaved as though a curtain which had been shutting them off from the world had been lifted. Their features became animated and conversation became possible; events which had occurred during the period of stupor were described, and replies to questions were coherent and relevant. Then, after a period of from two to twenty-five minutes, the retrograde changes began. The patients relapsed into their former mental state, inaccessible, mute and negative, and they resumed a posture identical with that which they had previously held. This observation is so new that its significance has only begun to be apparent, but its value in diagnosis and its bearing on the understanding of the nature of the psychosis is at once obvious. It gives promise of being one of his most brilliant contributions.

The achievements just recorded also represent the labors of many young workers starting on scientific careers. Dr. Loevenhart was ever on the alert for

signs of research ability among his students and when this was once detected it was most carefully nourished. Workers were attracted to him by the spell of his personality. They were admitted to his laboratory as part of the scientific family and given an independence which was limited only by the consciousness that they were harmoniously working together toward a common end.

The only dominating force in the laboratory was the intelligence and ready knowledge of its chief. Hours were spent by him in the elucidation of ways and means, more hours were spent in the meticulous preparation of statements for publication, yet in the end his claims for personal credit were extraordinarily modest. How much these years of association with Dr. Loevenhart were appreciated has been very touchingly expressed in letters written by his collaborators since his death.

Dr. Loevenhart was truly an apostle of the spirit of science, of science for its own sake and science for what it could contribute to the welfare of mankind. He was never so happy as when he could arouse or quicken the same spirit in others, and the extent to which he did so was one of his most conspicuous successes. Many of his former associates now occupy positions of responsibility in other schools, and the roster of the Pharmacological Society contains the names of ten members who have actively engaged in research in collaboration with him.

The high regard held for Dr. Loevenhart by his colleagues was shown by his position on many important committees and by the fact that he was twice made president of the Pharmacological Society. He had an enormous circle of friends, and at the dinners or smokers during any scientific gathering he could always be found surrounded by a group of them, who had gathered to listen to his witty and inspiring conversations enlivened by his inexhaustible supply of stories which always seemed to have such a pointed connection with the topic of the moment. His friends afforded one of the greatest pleasures in his life, and loyalty to a friend was one of his outstanding characteristics. The last years of his life were burdened by ill health, but they did not prepare his friends for his premature death at the age of fifty-one years. Throughout his ill health his cheerfulness never failed. Instead of diminishing his activity his illness seemed to spur him on to search more actively for means more immediately useful for the relief of the suffering of sick people. His last years were the most productive of his life, and his laboratory was one of the most active in the country.

The world at large will remember him as a scientist and a humanitarian, and a smaller group will remember him also as an inspiring teacher, but those who worked with him and played with him will remember him too as a lovable human being endowed with an indefinable charm.

H. S. GASSER

RECENT DEATHS

DR. CHARLES RANOLD MACINNES, associate professor of mathematics at Princeton University, died on September 29 at the age of fifty-three years.

DR. GEORGE F. WHITE, professor of chemical engineering in Clarkson College of Technology at Potsdam, New York, fell down a flight of stairs and was instantly killed on September 18. Dr. White for the last five years had been chemical engineer and director of the science department of Bauer and Black, of Chicago.

DR. WILLIAM FAIRFIELD MERCER met with almost instant death on July 29 at his summer home, Otto, N. Y. While Dr. Mercer was oiling his car it rolled backward crushing him underneath. Dr. Mercer had been head of the department of biology at Ohio University, Athens, since 1900.

DR. CHARLES AUGUSTUS BROWN, radiologist and founder of the Brooklyn Cancer Institute, died on September 27. He was fifty-six years old.

DR. GEORGE F. GAUMER, of Izamel, Yucatan, discoverer of several new mammals and author of a monograph of the mammals of Yucatan, died on September 2.

WALTER HEAPE, the English embryologist, died on September 10 at Tunbridge Wells at the age of seventy-four years.

THE death is announced of Dr. Richard Zsigmondy, professor of inorganic chemistry at the University of Göttingen. He was awarded the Nobel prize in 1928 in recognition of his work during the previous year in the field of colloidal research.

DR. MARIE, of the Pasteur Institute, Paris, has died from botulism contracted in the course of his researches on the disease.

SCIENTIFIC EVENTS

THE ROOSEVELT MEMORIAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

IT is announced that construction will soon begin on the great memorial to Theodore Roosevelt in New York City. On September 24 the bids were opened by Colonel Frederick Stuart Greene, of the State Department of Public Works at Albany for the foundation of this structure. At a luncheon given by Dr. Osborn, chairman, to Colonel Greene and the trustees

of the memorial prior to the opening of the bids, Professor Osborn took occasion to remark that it had taken ten years of unceasing labor to bring about the start of the undertaking with an initial appropriation of $1,000,000 by the Legislature.

The memorial is to face on Central Park West, the entrance being on 79th Street. For a long time it has been planned to construct an inter-museum promenade through Central Park, connecting the east and west sides of the city, the eastern terminal to be near the Metropolitan Museum and the western terminal facing the Roosevelt Memorial. By its means visitors would be afforded direct access to either institution by a path which would be safe at all times of the day or night and would give these great institutions far more accessibility than is now possible.

The building, as planned by the architect, John Russell Pope, will be approximately 200 feet square and six stories high. Its Ionic exterior will be built of pink granite to harmonize with the material used in the museum buildings. It will adjoin the new Whitney Wing on the north, the Asiatic Wing on the south and behind it, joining it to the museum on the west, will be erected the Akeley African Hall. Flanking the entrance for a distance of half a block on either side will be a curving terraced walk, while immediately in front, against the background of the sixty-foot entrance arch, will be an equestrian statue of Roosevelt in bronze on a polished granite pedestal. This statue is in course of preparation by the sculptor, James E. Fraser.

In order to secure the plot of land for the memorial it was necessary that the City of New York cede it to the state and on July 30 the board of trustees forwarded the deed to Albany for approval by the attorney-general and on September 5 the board was informed that the title had been examined and approved.

At the same time that the bids for the Roosevelt Memorial were opened by the state authorities, the city authorities opened bids for the construction of a new Power and Service Section estimated to cost $1,050,000 and for the Akeley African Hall to cost $1,450,000. Upon the completion of the preparation of the plans, bids will be requested for the construction of the Whitney Memorial Hall which is estimated to cost $1,500,000. This will adjoin the Roosevelt Memorial on the north. These four buildings it is expected will cost $7,500,000.

THE YALE INSTITUTE OF HUMAN RELATIONS

PRESIDENT JAMES ROWLAND ANGELL, of Yale University, announces that a gift of $500,000 has been received from the General Education Board for construction of the Institute of Human Relations building. This, with the sum of $1,500,000 previously given by the Rockefeller Foundation for the same purpose, provides a total of $2,000,000.

Ground has been broken this week for the building, plans for which have been completed. Every effort will be made to have it available for use at the beginning of the next academic year. Grosvenor Atterbury, of New York City, is the architect.

The institute is to be a center for research in biology and sociology. Its unique architectural features are a residential unit for the study of child development, a residential and treatment unit for the study of mental efficiency and mental diseases, modern laboratories for psychological investigations and facilities for research in sociology, including social psychology, economics and government.

The entrance is to be on Cedar Street, where the building will be joined with the Sterling Hall of Medicine. Broad Street is to be closed as far as Oak Street and a sunken garden will be created in the space now occupied by the roadway between the institute building and the Sterling Hall of Medicine.

At the spot where Broad Street, Oak Street and Davenport Avenue converge, a traffic circle 150 feet in diameter is to be formed. The approach to the human welfare group from the east will thus be impressive, with a perspective of the sunken garden, flanked by the institute and Sterling wings, affording a view of the Raleigh Fitkin Memorial Pavilion and other hospital structures across Cedar Street from the institute site.

Another entrance to the institute building will be in the middle of the long Davenport Avenue wing. This section will be devoted chiefly to the work of psychology and sociology. More than 30 rooms will be provided on the first floor for social science research. The section for psychology will include shops, optical rooms, sound-proof rooms, dark rooms, projecting rooms and laboratories, containing the most modern equipment available for the measurement of stimuli and the reactions of the human brain. On the top floor of this section of the building there will be a lounge and grille opening to the east and west.

In material the institute building will be identical with recent additions to the Human Welfare group. It will be constructed of red pressed brick trimmed with gray stone, in a modified Georgian style of architecture. At the Oak Street end the building will be five stories high, but on Cedar Street only four stories, because of the sloping ground.

With the erection of the institute building another step will have been taken in the development of the Human Welfare group, the purpose of which is to correlate scientific knowledge in the study of man as a whole, from the mental and social as well as the physical point of view.

THE PAN-AMERICAN INSTITUTE OF GEOGRAPHY

ACCORDING to a report in *The Christian Science Monitor,* the election of officers and the selection of Rio de Janeiro as the seat for the second general assembly of the Pan-American Institute of Geography and History formed the principal closing chapter of the institute at the adjourning session of the first general assembly of the institute.

With Mexico as the home seat of the institute, Dr. William Bowie, representative of the National Geographic Society and one of the American representatives at the local meetings, and Jose Toribio Medina, of Chile, were selected as honorary presidents. Salvador Massip, of Cuba, was selected as active president.

Members of the executive committee elected were Scipion Llona, of Peru; Dr. James Alexander Robertson, research professor of American history at the John B. Stetson University, and Rafael Helidoro Valle, of El Salvador. Pedro C. Sanchez, of Mexico, under whose chairmanship the Mexico City meetings have been held, was elected director-general, to be assisted in directing the work of the institute by Octavio Bustamente, also of Mexico, as vice-director general.

Other officers were selected from representatives of most of the Latin-American countries participating in the work of international advancement of natural science the institute aims to promote. The next meeting will be in three years at the Brazilian capital.

One of the last motions presented and passed unanimously was a vote of appreciation expressed to Mexico for the assistance rendered and the courtesies extended the delegates. A motion was adopted that a study be made of the possibility that Spain be allowed to participate in the future work of the institute, even though it is of Pan-American character.

Immediately following the adjournment, the delegates were received by President Emilio Portes Gil, who expressed his appreciation at the selection of Mexico as the permanent seat of the institute which will work for a better understanding between the peoples of the Western Hemisphere. It is understood to be the opinion of the United States delegation that a wise move has been made in the selection of a city other than Washington as headquarters for the institute in order that good-will and friendship may be promoted directly among the Latin-American countries and between them and the United States.

THE IRON ALLOYS COMMITTEE OF THE ENGINEERING FOUNDATION

DR. GEORGE B. WATERHOUSE, professor of metallurgy in the Massachusetts Institute of Technology, will head the iron alloys committee of the Engineering Foundation, according to an announcement made by H. Hobart Porter, chairman of the foundation, at a dinner at the University Club, New York, on September 25.

With the cooperation of industries, engineering societies, universities and the U. S. government, the committee will inaugurate a program of cooperative research called vital to the progress of the American iron and steel industry, whose future, it was stated, will be greatly affected by its ability to maintain a strong position in alloy irons and alloy steels. The research, the initial stage of which will require five years and which will cost $150,000, will, it is planned, be developed as an international enterprise, coordinating researches in ferrous metallurgy, the most important of which, according to engineers, are going on in America, England and Germany.

Other members of the committee, who will at once begin a critical review of all available literature in English and other languages, resulting in a series of monographs and manuals, were named as follows: Dr. George K. Burgess, director of the U. S. Bureau of Standards; Louis Jordan, of the bureau, alternate; Scott Turner, director of the U. S. Bureau of Mines; Dr. Charles H. Herty, Jr., alternate; R. E. Kennedy, technical secretary of the American Foundrymen's Association; Dr. H. W. Gillett, director of the Battelle Memorial Institute; Dr. Bradley Stoughton, director of the department of metallurgical engineering of Lehigh University; Jerome Strauss, chief research engineer of the Vanadium Corporation of America; T. H. Wickenden, metallurgical engineer of the International Nickel Company, and Dr. John A. Mathews, vice-president of the Crucible Steel Company of America.

The Iron Alloys Committee, said Mr. Porter, who is president of the American Water Works and Electric Company, will work in cooperation with the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Iron and Steel Institute, the Society of Automotive Engineers, the American Society for Steel Treating, the American Society for Testing Materials, the U. S. Bureau of Standards, the U. S. Bureau of Mines, numerous corporations in the metallurgical industries and several universities. There are encouraging indications, he added, that foreign cooperation also may be arranged.

PRINCETON DOCTORATES OF SCIENCE

ON the occasion of the dedication of the new chemical laboratory at Princeton University, on September

26, doctorates of science were conferred with citations as follows:

IRVING LANGMUIR, president of the American Chemical Society, and recipient of prizes and honors from national and foreign societies in both physics and chemistry. In 1909 he was called to take a leading part in carrying out a far-sighted policy of fostering research in pure science, adopted by the General Electric Company. In the laboratory of this great industrial corporation, Langmuir has for twenty years attacked fundamental problems with the freedom of an academician, yet with all the powerful resources of the industrial engineer. Langmuir's is the accepted concept of adsorption and orientation of molecules at surfaces; his studies have furnished us a mechanism of gas reactions at the surface of the metal tungsten, universally used in electric illumination, long-distance telephony and radio.

MAX BODENSTEIN, professor of physical chemistry in the University of Berlin. His series of classical researches on the velocity of chemical transformations has enriched the subject of reaction kinetics. To Bodenstein is due the concept of chain reactions, which has been of fundamental importance in the explanation of chemical reactions in general.

SIR JAMES COLQUHOUN IRVINE, principal and vice-chancellor of the University of St. Andrews. While professor of chemistry he won a world-wide recognition as expert on the structure and synthesis of organic compounds, notably of the sugars and of cellulose.

JEAN BAPTISTE PERRIN, Nobel prize laureate, director of the laboratory of physical chemistry of the University of Paris, and director of the newly-founded Rothschild Institute for Research in Biophysics. His masterly analysis of the "Brownian movement" of small particles has laid the foundation of a rational study of colloidal systems and thus opens the way for further and much-needed work in biophysics.

FREDERICK GEORGE DONNAN, professor of chemistry in University College, London. His pioneer work on equilibria of salt solutions at membranes has guided innumerable studies of the conditions obtaining in living matter and has determined in great measure the direction which biophysical research has taken.

SCIENTIFIC NOTES AND NEWS

THE autumn meeting of the National Academy of Sciences will be held at Princeton, N. J., on November 18, 19 and 20, 1929. Professor W. B. Scott is chairman of the local committee on arrangements.

MME. CURIE will be the guest of honor at the third annual dinner of the New York City committee of the American Society for the Control of Cancer, which will be held at the Hotel Plaza on the evening of October 31. It is understood that this will be the only social event that Mme. Curie will attend during her brief stay in the United States.

BY vote of a committee representing the chemical societies in the United States the Perkin medal for 1930 will be awarded to Dr. Herbert H. Dow. The presentation will be made on January 10, 1930, at a joint meeting at the Chemists' Club. It is expected that other speakers on the program will be James T. Pardee, E. O. Barstow and William H. Nichols. The medal is awarded for the achievements of Dr. Dow as represented in the fields of bromine, alkalies, magnesium and magnesium salts, phenols and other developments of his organization.

THE Grasselli medal for 1929 has been awarded to Professor Bradley Stoughton and the formal presentation will be made on November 8. The special reason for which this is awarded is a paper on "Light Structural Alloys" presented several years ago. Professor Stoughton will speak on "Materials for Aircraft Construction."

THE *Journal* of the American Mathematical Society notes the following awards: The Vienna Academy of Sciences has awarded its Lieben prize, for the best mathematical work by an Austrian during the preceding three years, to Professor Karl Menger, for his memoirs on the theory of dimensions; the Royal Academy of Naples has awarded its biennial prize to Professor Enea Bortolotti, for his memoir entitled *Geometria degli spazi riemanniani;* the gold medal of the Royal Astronomical Society has been awarded to Professor Ejnar Hertzsprung, of the Leyden Observatory, for his work in stellar astronomy; the Royal Society of Edinburgh has awarded its Gunning Victoria Jubilee prize for the period of 1924–28 to Professor E. T. Whittaker, for his contributions to mathematical science and the promotion of mathematical research in Scotland.

THE first Harrington lecture of 1929–30 at the medical school of the University of Buffalo will be given by Professor Joseph Barcroft, F.R.S., of Cambridge University, England. The subject will be "Life at the Snow Line in the Andes."

THE Brooklyn Museum announces the appointment of Dr. Herbert J. Spinden as curator of ethnology in the museum of the Brooklyn Institute of Arts and Sciences. Dr. Spinden goes to Brooklyn from the Peabody Museum at Harvard University, where he has been curator of Mexican archeology since 1921.

MONTROSE W. HAYES, now in charge of the St. Louis, Missouri, station of the Weather Bureau, has been appointed to succeed the late Dr. Harry C. Frankenfield as chief of the river and flood division in the central office of the bureau in Washington, D. C.

JOHN P. TILTON, formerly on the teaching staff at Tufts College and associated with the psychological laboratory at Harvard University, will be in charge of one of the groups in business psychology at the Babson Institute, Wellesley Hills, Massachusetts.

DR. JOHN GORDON THOMSON, director of the department of protozoology, London School of Hygiene and Tropical Medicine, has resigned the position and has been appointed principal of the department of parasitology at the Ross Institute for Tropical Diseases, London.

HENRY L. JOHNSON, of the Graphic Arts Company, Boston, Massachusetts, has been appointed curator of graphic arts in the Museum of Science and Industry, founded by Mr. Julius Rosenwald, of Chicago. Mr. Johnson will prepare exhibits which will trace the history of printing and the graphic arts in general from their beginnings to the present time. Mr. Helmuth Bay has been appointed head of the division of forestry and lumbering. In cooperation with Dr. Russell H. Anderson, curator of agriculture, Mr. Bay is planning the exhibits to demonstrate the nature of industrial woods, as well as their application in industry, and the methods of lumbering and wood-working machinery. Mr. Ernest Kohler, a graduate engineer of the Massachusetts Institute of Technology, has been selected to assist Dr. Andrew M. MacMahon, curator of physics, in the capacity of communication engineer. The museum will present the history of communication by means of three dimensional working models, motion pictures, dioramas, etc., and will include in the exhibits practically every means of communication that has been devised by man.

NEIL M. JUDD, curator of American archeology, U. S. National Museum, returned to Washington on September 23 from four months' field work in Arizona in behalf of the National Geographic Society. Mr. Judd's investigations this year were primarily concerned with collection of beams from prehistoric Pueblo ruins. With these old timbers it is hoped to bridge the single remaining gap in the "tree ring" chronology being erected by Dr. A. E. Douglass, of the University of Arizona, and thus make possible the dating of Pueblo Bonito and other pre-Spanish ruins of the southwest. While under the general direction of Mr. Judd, the society's 1929 excavations were directly supervised by Messrs. L. L. Hargrave, of the Museum of Northern Arizona, at Flagstaff, and E. W. Haury, of the University of Arizona, at Tucson. Dr. Douglass is now engaged in reviewing the material resulting from the expeditions; a midwinter report is anticipated.

DR. E. B. RENAUD, professor of anthropology at the University of Denver, has returned from a two months' expedition for the Colorado Museum of Natural History. He discovered human and cultural remains of a primitive form of basket-maker culture, thus extending far to the northeast the area of that prehistoric culture so far centered along the New Mexico-Arizona boundary.

DR. EVERETT S. SANDERSON has resumed his work as head of the department of bacteriology and pathology in the medical school, University of Mississippi, after having spent the summer as a special member of the Rockefeller Foundation, International Health Division, investigating respiratory disease at St. John, Virgin Islands.

THE China Foundation for the Promotion of Education and Culture has invited Professor H. H. Whetzel, of the department of plant pathology at Cornell University, to spend a year or more in China. He will be expected to lecture in the various agricultural institutions of China and to assist in the organization and development of phytopathological work in the republic.

DR. E. P. SANDSTEN, state horticulturist and head of the department of horticulture at the Colorado Agricultural College, has returned from Sweden where he went to study the various experiment stations and to Gallivore in northern Sweden to study the use of electricity in farming.

DR. H. G. DEMING has resumed his work as professor of chemistry at the University of Nebraska, after having spent a year with Arthur D. Little, Inc., at Cambridge, Massachusetts.

DR. HANS PRINZHORN, of Freiburg, Germany, who since 1922 has been practicing physician in psychotherapeutics in Freiburg and from 1919 to 1922 was assistant in the Psychiatric Clinic in Heidelberg, is making a visit to the United States. Dr. Prinzhorn attended the International Congresses of Psychology and of Physiology, at both of which he read papers on the results of some of his investigations. He will be available for lecture engagements until December 20, under the auspices of the Institute of International Education.

DR. BERNARD HAGUE, principal lecturer in electrical engineering at the University of Glasgow, Scotland, has accepted the invitation of the Polytechnic Institute of Brooklyn to serve as visiting professor of electrical engineering for the present academic year. Dr. Hague, who has degrees from the Universities of London and Glasgow, is the holder of the Siemens medal for electrical engineering and the Henrici medal for mathematics. He is a member of the Institution of Electrical Engineers, and the author of several standard works on electrical theory and mea-

surements. He will have charge at Brooklyn Polytechnic of the conduct of graduate study and research in electrical engineering in the new plan now being developed at that institution for the benefit of technical graduates in the metropolitan district who desire to earn advanced engineering degrees by evening study.

ON August 26, at the invitation of the Commissioner of Fisheries, the American Button Manufacturers Association met at the U. S. Bureau of Fisheries Biological Station at Fairport, Iowa, to witness the first public demonstration of the new method for fresh-water mussel propagation. This method, in which the mussel glochidia normally parasitic on the gills of certain fishes are caused to develop in special nutrient solutions, was worked out by Dr. Max M. Ellis, professor of physiology in the University of Missouri, and Mrs. Ellis, as the result of a long series of experiments conducted by them at the Fairport Station during the past four years. By means of this process, which eliminates the normal parasitism of these various mussels, controlled plantings of valuable mussel species are now possible, and the restocking of depleted streams put on the same basis as the restocking of streams with fish fry. At a banquet held that evening in the city of Muscatine, Iowa, Mr. T. K. Chamberlain, director of the Fairport Station, and Dr. Ellis explained the applications of the new method to the problems of the button industry.

TECHNICAL committees representing five national societies interested in European corn-borer research and control, and a general committee on the allocation of such research work, met for their regular field conference at Toledo, Ohio, from September 25 to 28. The time was largely spent in making a detailed examination of the research and control work, in studying the status of the corn-borer infestation, and in the preparation of a report for their respective societies. The societies concerned are: American Association of Economic Entomologists, American Society of Agronomy, American Society of Agricultural Engineers, American Farm Economic Association and American Society of Animal Production. To strengthen the work of these committees, the various state regulatory officials have been invited to attend the conference, together with well-known farmers and educators from various parts of the Corn Belt.

THE seventh International Meteorologists Congress opened at Copenhagen on September 16 in the Danish parliamentary building under the presidency of Professor Van Everdingen. The diplomatic corps attended the opening speech of the Danish defense Minister Rasmussen, after which Professor Van Everdingen answered, thanking Denmark. The congress, consisting of thirty-two state meteorologists, and about a hundred others, discussed the detailed programs of polar investigations to be made in 1932 and 1933.

THE International Neurological Congress will be held in Berne (Switzerland), from August 31 to September 4, 1931. At the recent meeting of the Program Executive Committee, Dr. Bernard Sachs, of New York, was elected president of the congress and Dr. H. A. Riley, of New York, was elected secretary-general. Dr. Charles Dubois, of Berne, will be the local secretary. The eight vice-presidents are: Sir Charles Sherrington (Great Britain); Professors Guillain (France); Nonne (Germany); Bing (Switzerland); Rossi (Italy); Marburg (Austria); Kappers (Holland), and Marcus (Sweden).

A PHYTOPATHOLOGICAL SOCIETY of China has been founded at Nanking. The president is Professor F. D. Tai, head of the department of plant pathology in the University of Nanking, and the secretary, Professor S. C. Teng, head of the department of plant pathology of the Central University in Nanking.

THE Biological Survey of the Mount Desert Region, under the auspices of the Corfield Laboratory, is being conducted by Mr. William Procter and a staff of seven men, including Dr. H. C. Tracy, of the University of Kansas; Dr. E. R. Helwig, of the University of Pennsylvania; Mr. Phil Powers, of the University of Kansas; Dr. C. H. Blake, of the Massachusetts Institute of Technology, and Mr. Simon Cohen, of the University of Kansas. A new dredging boat, the *Lophius,* of ample size, built after plans of Mr. Procter, was put in commission this season and proved of great service to the survey. The boat crew are men of experience and skill in the waters of Mount Desert. The mapping of stations, the identification of forms found at the various stations, the water temperature at varying levels and many other data have been systematically recorded and card catalogued. The Survey of the Mount Desert region is now cooperating with a number of institutions interested in the work, in addition to its close affiliation with the institute.

AT the time of the celebration of the centenary of Marcelin Berthelot in October, 1927, plans were made for a permanent memorial in his honor. This was to be a house of chemistry, not only to serve the chemists of France, but to be a meeting place for the chemists of all nations. *Industrial and Engineering Chemistry* now reports that the French Senate has recently approved the purchase of the La Rochefoucauld-Estissac house, 28 Rue St. Dominique, and has voted an appropriation of 15 million francs for this purpose.

The fund of about 25 million francs which had been collected for the project will now be available as an endowment for perpetuating the work, with the exception of the small amount needed for alterations to the building. The location of the Maison de la Chimie in the Rue St. Dominique, which is just behind the Chambre des Deputies, in the immediate vicinity of the Place de la Concorde and the Esplanade des Invalides, and quite near the center of Paris, is a compromise between the university quarter, favored by Berthelot's successors among the university professors, and the more modern section of the city, favored by those looking toward the future. The building is a spacious one, admirably adapted as a meeting place and social quarters for chemists, and with ample space for the erection of such special accommodations as may be needed.

THE California State Legislature during its last session passed a bill appropriating through the University of California the sum of $40,000 for a new laboratory building and essential improvements in connection with it for the Scripps Institution of Oceanography, on condition that a similar sum be received from some outside source. The needed additional sum of $40,000 has now been pledged and plans for the building are gradually being perfected. It is intended to have four kinds of oceanographic investigations prosecuted in the new building, as follows: dynamical oceanography and marine meteorology; the chemistry of the sea; marine bacteriology, and the physiology of marine organisms with reference to the oceanic environment. Although the date for the completion of the building can not yet be set, it is probable that construction will be finished by next summer.

ACCORDING to a report made public by the Bureau of Reclamation, H. A. Parker, superintendent of the Lower Yellowstone project, Montana-North Dakota, and F. E. Roddis, district counsel, at Billings, Mont., have discovered a petrified forest on Indian Coulee, about three miles southwest of Savage, Mont. With federal aid the state of Montana is reconstructing eight miles of the main highway from Glendive, Mont., to Williston, North Dakota. This is the principal road through the Lower Yellowstone project. The reconstructed highway crosses Indian Coulee in some picturesque bad-land territory. Adjacent to the roadway on the west side are several acres of fallen petrified trees. Some of them are ten feet in diameter and over 100 feet long. The tops of the trees taper off abruptly, indicating they belonged to the coal-tree forests of that geological age; furthermore, this conclusion is supported by the location of a vein of coal in an adjoining hill, which appears to be on the same earth strata. The trees have fallen in the same direction, leading to the belief that they were uprooted by a violent southeast wind. Over an area of thirty miles wide and 100 miles long in eastern Montana pieces of petrified wood can be found, but this is the first forest of petrified trees lying in place as they had fallen. The silicate deposit which turned the trees to stone has not crystallized, and none of the wood rings of the trees is visible.

A CORRESPONDENT of the *Journal* of the American Medical Association points out that before the war, the German Empire, with average annual totals of 2,000,000 births and 1,200,000 deaths, had an annual excess of births over deaths of about 800,000, or from 12 to 14 per thousand inhabitants. In 1927 there were only 1,160,000 births, or 18.3 per thousand of population; 757,000 deaths, or 12.0 per thousand, and an excess of births over deaths of 403,000, or 6.4 per thousand. The annual excess of births over deaths has thus dwindled down to half that of the prewar status. The excess of births over deaths that is still recorded to-day is, however, a delusion that arises from the present peculiar distribution of the age groups. An analysis freed by means of refined methods of research from the accidental data of the distribution of the age groups reveals the true demographic position to-day. According to this adjustment of statistics, the death rate, on the basis of the present average length of life (57.4 years), is not 12 per thousand, as is stated according to the unadjusted computation, but 17.4 per thousand, whereas the birth rate, on the other hand, on the same readjustment basis, is not 18.3 but 15.9 per thousand. These adjusted birth and death rates give, instead of an excess of births over deaths of 6.4 per thousand, a deficit of 1.5 per thousand of population. In other words, the adjusted birth rate of Germany is, on the average, about 10 per cent. below what is needed to preserve the population of the country. In Berlin, the birth deficit amounts now to 57 per cent. (almost three fifths), and the average birth deficit of the large cities of Germany is 42 per cent. (slightly more than two fifths). The large cities are no longer able to preserve their present status of population by virtue of their own inner strength, and even the middle-type cities and the small towns, whose birth rates, on the average, are lower than the birth rates of such metropolitan centers as Paris and London, have already a birth deficit of approximately a third (31 per cent.). Only in the rural regions does one occasionally find birth rates in excess of the minimal requirement for the preservation of the population. But the life assets of the rural population are now no longer sufficient to compensate for the birth deficit of the urban population.

UNIVERSITY AND EDUCATIONAL NOTES

DR. ALEXANDER RUTHVEN, dean of administration in the University of Michigan, has been appointed acting president of the university.

DR. WILLIAM S. FRANKLIN, since 1917 professor of physics at the Massachusetts Institute of Technology, has become professor of physics at Rollins College.

PROFESSOR ALDEN B. DAWSON, of the University Heights section of the department of biology, New York University, has accepted a call to the department of zoology at Harvard University. The following new appointments in biology at University Heights have been made: Associate Professor Otto M. Helff, of the University of Iowa, to be associate professor; Dr. Daniel Ludwig, University of Pennsylvania, to be assistant professor, and Dr. Carl J. Sandstrom, University of Chicago, instructor.

APPOINTMENTS at Union College include the following assistant professors: Ernest E. Dale, of the University of Porto Rico, in biology; Dr. Hugh H. Hyman, in physics, and Dr. Ernest M. Ligon, in psychology.

MILLARD PECK, bureau of agricultural economics of the Department of Agriculture, has become professor of agricultural economics in Iowa State College, Ames.

JAMES R. THAYER has resigned his position as research chemist at Parke, Davis and Company, to become assistant professor of materia medica in the California College of Pharmacy, San Francisco.

DR. EARL C. O'ROKE, of the University of California, who has been carrying on research in zoology for the California Fish and Game Division, has been appointed assistant professor of forest zoology in the University of Michigan School of Forestry and Conservation.

DR. NORBERT WIENER, of the Massachusetts Institute of Technology, is visiting professor of physics at Brown University, and Dr. Arthur M. Banta, of the Carnegie Institution at Cold Spring Harbor, N. Y., has been appointed acting professor of biology. Dr. William A. Noyes, Jr., of the University of Chicago, has been appointed associate professor of chemistry.

PROFESSOR DR. CHARLES TERZAGHI, of the Massachusetts Institute of Technology, has accepted a call to a professorship of hydraulics at the Viennese Technical High School.

M. DAGUIN has been appointed professor of geology and mineralogy at Bordeaux to succeed M. Mengard.

DISCUSSION

SOME NEW LAWS FOR THE SOLAR SYSTEM

APROPOS of A. E. Caswell's suggested law, namely, "the mean distances of the planets from the sun are proportional to the squares of simple integral numbers," the writer wishes to point out the following corrections, extensions and other new laws.

(1) The percentage deviation from proportionality to the *squares* of the integers is double that indicated by him.

(2) Since the earth's distance is taken as a standard in all measurements, one would expect a good reason for not assuming its distance to correspond to a perfect square of an integer (in this case 5). If this is done the deviations from the above law are as high as 12 per cent.

(3) One would expect similar relations to hold for the satellites of the planets. For the satellites of Mars the ratio $5^2 : 8^2$ holds quite closely. For the four satellites of Uranus the ratio $5^2 : 6^2 : 8^2 : 9^2$ holds poorly. But for the satellites of Saturn and Jupiter one must either omit several or resort to initial numbers greater than 5^2 for the nearest satellite. Of course, if large integers are to be admitted one may get as close a fit as one pleases for almost any distribution of distances. On the whole the evidence from this source is unfavorable to a deep-seated significance for the relation cited.

(4) The writer would point out a relation that depends *strictly* on the square root of the distance of a planet from the sun or a satellite from its planet. It is the velocity, which varies inversely as the square root of the distance from the axis of revolution. For the planetary system one could then state as a law: *The velocities of the planets are inversely in proportion to simple integral numbers.* Thus,

Planet	Period	Mean velocity	30.3/mean velocity	Nearest integer
Mercury	0.2408	10.1006	3	3
Venus	0.6152	7.3872	4.1	4
Earth	1.000	6.2832	4.83	5
Mars	1.88	5.0924	5.95	6
Jupiter	11.86	2.7563	11.0	11
Saturn	29.46	2.0344	14.9	15
Uranus	84.01	1.4346	21.1	21
Neptune	164.6	1.1464	26.5	27

(5) Another law may be stated, as a consequence of Kepler's third law and the distance relation, namely, *the periods of the planets are proportional to the cubes of simple integral numbers.*

The same integers as above are involved.

(6) In this connection the writer would bring to the attention of American scientists an effort by Viktor Goldschimt[1] to elucidate some of the numerical regularities in the distances of planets and satellites from their axes of revolution. The journal in which it occurs is not generally known. He observes the distances of the planets to be quite closely in the sequence 1/13, 1/7, 1/5, 1/3, 1, 2, 4, 6. The four larger planets are considered to have condensed together before the group of the four smaller ones. A mathematical treatment strictly analogous to the phenomena of *standing waves in sound,* the distribution of lines in spectra, the progress of crystallization and similar phenomena gives the same law of harmonic relations of distances not only for the planets but also for satellites. The harmonic sequences are as follows:

Condensations	0	1/3	1/2	2/3	1	3/2	2	3	∞
Large planets	0		1/2		1		2	3	∞
Small planets	0	1/3		2/3	1		2		∞
Jupiter's satellites	0		1/2	2/3	1		2		∞
Uranus' satellites	0		1/2	2/3	1	3/2			∞
Saturn inner satel.	0		1/2	2/3	1	3/2	2		∞
Saturn outer satel.	0				1	(6/5)		3	∞
Earth moon	0				1				∞

The sequences are brought into line by transformations derived from considerations of the dominance of certain positions, as the 0, 1 and ∞ in condensation.

(7) The writer would further approach the question of the regularities of the spacing of the planets from another basic point of view. In brief, considering the accurate correspondence of the velocity of a planet or satellite inversely to the square root of its distance from the axis of revolution, we may conceive the propagation of a wave of velocity at the initiation of revolution to follow the law of a logarithmic spiral. We should then expect the distances of the planets as well as their velocities to be represented as the radii vectors of a logarithmic spiral. The law we would propose is: *A small integral number of geometric means will determine the positions and velocities of all the planets and satellites.* This is suggested by the well-known properties of such spirals. Symbolically,

$$\log d = nk, \text{ or } e^{nk} = d$$

where d is the distance, k is a constant and n is a *simple integer.* A fairly accurate straight line plot is obtained by using values of n for the entire series between Mercury and Neptune, *1, 4, 5, 7, 10, 13, 16, 19* and *21.* The interval of 3 predominates. The velocity, v, is related to the above by the relation

$$\log v = k' - \frac{nk}{2}$$

where k' is another constant and n the *same simple integer as above.* It follows also that a similar logarithmic relation exists for the periods, that is, *a small number of geometric means will determine the periods.* If p stands for the period, then

$$\log p = \frac{3}{2}nk + k''$$

where k'' is still another constant and n is *the same simple integer as above.*

Similar relations may be derived for centripetal force and the like, but enough has been given here to indicate the underlying principle.

WILLIAM MARIAS MALISOFF

NEW YORK, N. Y.

[1] *Annalen der Naturphilosophie,* Vol. V, pp. 51–118.

A STUDY OF THE FIRE BLIGHT PATHOGEN, BACILLUS AMYLOVORUS, WITHIN LIVING TISSUES

IN a previous article Rosen and Groves[1] showed that blossom infection of Japanese (flowering) quince may readily be accomplished either by injections or by spraying with a water suspension of *Bacillus amylovorus.* The relative ease with which infections were obtained by either of these methods suggested a reexamination of the methods by which blossom infections are brought about under field conditions upon various hosts. In the meantime, an article by Miller[2] appeared in which stomatal infections were described for a young apple leaf and for the "inside of the receptacle cups of apple and pear flowers that were open when inoculated." The present note is for the purpose of calling attention to the wholly unexpected results that have been obtained in petalary infections of pear blossoms. A more detailed report, with photomicrographs, will appear later.

When pear blossoms in which the petals are closed and tightly clasped together are sprayed with a water suspension of *B. amylovorus* and placed in a moist chamber for twenty-four to forty-eight hours, infections will commonly occur on receptacles, sepals and petals. The number of infections as well as the extent of any one individual infection will depend on a number of conditions and it can be reported that infections may be obtained in great numbers within forty-eight to seventy-two hours after inoculation. It seems

[1] *Jour. Agr. Res.,* 37: 493–505, 1928.

[2] SCIENCE, 68: 386–388, 1928.

that such infections have not been recorded as yet in the literature on this disease.

The main purpose of this note is to direct attention to the infections on the petals. When a single petal containing one or more localized infections is mounted in water and examined under the microscope the bacteria can be observed within the living tissues without recourse to sectioning or staining. The very delicate, translucent, petalary tissues admit of remarkably clear views of the interior structures, and at magnifications of around 800 the live bacteria can be readily observed. For studying the activity of micro-organisms within living tissues it would be difficult to find more suitable material than these petals. Aside from this, any one who has attempted to study blighted tissues knows how difficult it is to avoid losing large numbers of bacteria in the process of obtaining histological sections.

The forty-eight-hour-old infections take the form of dark, discolored spots which are more or less limited in size and have a well-defined margin. Under the microscope the discolored tissue is readily distinguished from the adjoining healthy part and is seen to consist of a zone of cells between which the bacteria can be traced to the very margin of the discolored region, strongly suggesting that the discoloration and possibly other pathological phenomena are associated with the immediate presence of the bacteria.

This close association of diseased cells with the bacteria is further emphasized by the enormous numbers of rods that are wedged in tightly between the cells, numbers far beyond anything that has previously been noted or pictured for any blighted tissue. For the present it may be briefly recorded that a great deal more is involved here than passage through intercellular spaces. *B. amylovorus* within petals acts as a strict parasite whose growth and reproduction is confined to living host cells. The method of penetration and the cytological and pathological phenomena noted in the infected region will be reported later.

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PROPOSED AMENDMENTS TO THE INTERNATIONAL RULES OF NOMENCLATURE

1. Art. 19. Amend to read:

Botanical nomenclature begins for all groups of plants (recent and fossil) at 1753 (Linnaeus, "Species Plantarum," ed. 1).

It is agreed to associate genera, the names of which appear in Linnaeus's "Species Plantarum," ed. 1, with the descriptions given of them in the "Genera Plantarum," ed. 5 (1754).

2. Art. 49 bis. Amend by eliminating the words: "starting from Fries, *Systema,* or Persoon, *Synopsis*"; and for the words "teleutospore or its equivalent" substitute the words: "uredospore or teleutospore (sporophyte)."

Also replace the first example by the following: The names *Aecidium* Pers., *Roestelia* Reb., *Aecidiolum* Unger. and *Peridermium* Chev. designate different states of the gametophyte in the group *Uredinales.* The generic name *Aecidium* Pers. [in Gmel. Syst. Nat. II. (1791)], belonging to a gametophytic state can not displace *Gymnosporangium* Hedw. f., [DC. Fl. Fr. II. (1805)] based upon the sporophyte.

3. Add the following genera to the list of Nomina Conservanda: *Uromyces* (Link) Unger, 1833 (in place of *Nigredo* Rouss., 1806, *Caeomurus* (Link) S. F. Gray, 1821, or *Pucciniola* March., 1829); *Puccinia* Pers., 1794 (in place of *Puccinia* [Micheli] Adans., 1763, or *Puccinia* Willd., 1787); *Gymnosporangium* Hedw. f., 1805 (in place of *Puccinia* [Micheli] Adans., 1763; *Melampsora* Cast., 1843 (in place of *Uredo* Pers., 1794).

Comments: In the considerable number of replies to the circular letter distributed to many botanists early in March, and printed in *Mycologia* (21: 172–174), there was almost unanimous agreement to the proposed amendment to Article 19, as given above. The replies came from leading writers in systematic botany, mycology, algology, bacteriology, paleobotany, bryology and other divisions of the subject.

The proposed amendment to Article 49 bis., as previously suggested by the author, met with decided opposition. As now worded, it has the effect to restore the original intention of the "Rule," as adopted at Brussels. It eliminates the aecidiospore, and thereby disposes of many recent combinations, to which much objection has been made. It retains the uredospore, which belongs to the same state of the fungus as the teleutospore, for otherwise many familiar names would be rejected, such as *Coleosporium Ipomoeae* Burr., *Uromyces Fabae* deBary, *U. appendiculatus* Fries, *Puccinia glumarum* Erikss. and Henn., *P. Porri* Wint. and other generally accepted names. It also conserves such names as *Puccinia graminis, P. sessilis, P. coronata, P. Poarum, P. limosa,* etc.

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ODD STORIES ABOUT SCIENTIFIC NAMES

THE other day I was swapping taxonomic yarns with a fellow entomologist and it occurred to me that there must be many readable stories of that kind that have not yet been published. So I am sending two of those stories, that I told, to SCIENCE with the idea that perhaps other zoologists and botanists will send others in from time to time, so that

eventually a large number of hitherto unrecorded yarns may be found in print.

When the Fluted Scale was doing great damage to the citrus groves of California, it became rather generally known by its generic name Icerya. People inquired the meaning of this strange word. A scientific man with some philological knowledge wrote a letter to the Los Angeles *Times* (in 1888, I think it was) in which he explained that it was one of those unfortunate bastard names derived from two languages—the Greek *isos,* meaning straight, and the Latin *cerum,* meaning wax—the names evidently being descriptive of the straight waxy secretions of the insect. This was plausible and ingenious. But to those of us who knew that Signoret, the French authority, named it after Dr. Icery, of Mauritius, who sent him the original specimens, the *Times* letter was a rather good joke!

Many years ago a writer in Mexico established a genus which he called Freisuila for certain curious insects of the family Psyllidae. We puzzled long about the possible etymology of this name. It stumped the best zoological philologists in Washington. Years later I met the Mexican savant and asked him about it. He told me that he had a great reverence for his old master, Alfredo Dugès, of Guanajuato, and that he had named this genus after his master's wife's maiden name—Louisa Frey—putting it in anagrammatic form.

Will SCIENCE open its columns to botanists and zoologists who may think it worth while to send in other curious stories like these?

L. O. HOWARD

SCIENTIFIC APPARATUS AND LABORATORY METHODS

NEW METHODS IN THE STUDY OF FOSSIL SHARK TEETH

SINCE Mid-Paleozoic times sharks have been an important type of marine life. Unlike other forms of fish, however, they have been marked throughout their range of development by the possession of a cartilaginous skeleton which is incapable of preservation in fossil form except under unusual conditions. Studies in their evolution in bodily form and structure, therefore, are generally relegated to the field of theory and conjecture.

It is true that sharks have at different periods shown tendencies of developing partially calcified skeletons, but the process has never developed beyond the point of a slight calcareous strengthening of the cartilage in some forms, and in others the formation of rings of the same material imbedded in the vertebrae. At times, also, they have developed protective calcareous tubercles and spines capable of preservation as fossils, but of doubtful value in establishing relationships because these features are merely the result of specialization. Early in their development, however, and due to their predaceous habits, the sharks acquired a remarkably efficient dentition which they have retained ever since. Many of these teeth are found to-day in perfect condition, and form the basis of most studies of extinct sharks.

Soon after the death of an individual shark the decay of the cartilaginous jaws results in the teeth becoming separated and scattered over a wide area. Very rarely are more than several teeth from the same individual found in one place, and since a single shark may have had as many as several hundreds of teeth the reconstruction of the dentition has been almost impossible. This not only affects the determination of the number of teeth of the different species but the classification of the teeth themselves, since in the same jaw the forms of the teeth varied greatly.

As a result of this unfortunate situation the classification is in a chaotic condition, and is probably correct only as far as determination of family. In many instances teeth originally adjacent in the jaw of an individual shark have shown differences sufficiently great that they have received separate specific names; or the differences may have been so marked as to lead to their being placed in different genera. Several such cases are known, the errors becoming evident only in the rare instances when the teeth were finally discovered in their proper relationships. Naturally, the result of such unsound interpretations has been that in both laboratory and field work little geologic importance is now attached to fossil shark teeth. The writer believes, however, that examination of them on an entirely different basis from outward form will result in positive determination of species, and that such fossils will become of great value in stratigraphic geology. The basis of this new method of determination is the proven fact that in the same species, no matter to what extent the teeth may vary in form or in number, they all show the same internal structure, and in no two species is this structure identical. Besides enhancing their value in stratigraphic work, the possibility of their certain identification in the future makes them of great importance in studies of morphology.

With this fact in mind the writer has undertaken to examine the collection of fossil shark teeth in Walker Museum at the University of Chicago. This collection, though large, is far from complete. Because of

this fact and the difficulty of securing specimens from other museums it will be impossible to describe all the known fossil teeth. Therefore it is hoped that others who may have supplementary material available will be sufficiently interested in the work to communicate with the writer.

The study requires that microscopic sections of the teeth be made, since their interior structure is very minute. At least three sections must be made of each tooth, and, if the tooth is large, enough more to show all its characteristics. It is also necessary that these sections be made so that they correspond in position with those of other teeth in order to establish a uniform basis of comparison. The three standard sections comprise: one of the grinding or biting surface (called the crown section), one taken parallel to the crown section through the tooth at a point about half way down the side (called the medial section) and one taken vertically from root to biting surface (called the vertical section). In order to facilitate comparison of the teeth, microphotographs are made of each section.

The description of the teeth on the basis of microscopic structure will require a new system of nomenclature. The problem resembles very much that of the description and classification of the bryozoans which was so admirably accomplished by Ulrich and Bassler. The introduction of descriptive terms new to the science necessitates adequate definition of them as an introduction to the study. Familiar terms such as enamel, root, pulp, etc., will be used whenever possible.

The work of sectioning and photographing the teeth is almost complete for the Psammodont and Petalodont families of the Walker Museum collection. When the other families are finished the work of reduction of species and the correction of classifications will be undertaken. It is possible that enough teeth of a single species may be present in the collection to warrant the reconstruction of the dentition of some forms.

It is the writer's hope that as a result of this study the geologist engaged in field work of either paleontological or stratigraphical nature, or both, will regard fossil shark teeth as valuable additions to his collection, since it will no longer be necessary to compare them with hundreds of others in books or in collections to make doubtful determinations. Under the new plan the geologist will make sections of the teeth as indicated above, and after carefully noting the characteristics by microscopic examinations he will be able to make positive determinations by either the trial and error method or by elimination. It is only when such positive identifications are possible that fossils become of stratigraphic value. In this connection the stratigraphic range of each of the species studied will be established wherever possible. Such information in table form will be an important part of the paper.

This work is being done under the supervision of Dr. Carey Croneis and Dr. Alfred S. Romer, of the department of geology (paleontology division) of the University of Chicago.

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SPECIAL ARTICLES

THE INTERNAL TEMPERATURE OF THE EARTH'S CRUST

RECENT investigations in the utilization of the earth's internal heat led the author to consider the possibility of obtaining an equation which would represent the average temperature gradient of the earth's crust. The use of the linear gradient of 1° F. in 55 ft. is not satisfactory because it leads to large errors at even shallow depths.

Kelvin's equation (Thomson and Tait, "Treatise on Natural Philosophy," vol. 2, p. 458, 1883) which yields the solution,

$$\vartheta = \frac{2\vartheta_o}{\sqrt{\pi}} \int_o^\beta \epsilon^{-\beta^2} d\beta \text{ and } \frac{d\vartheta}{dx} = \frac{\vartheta_o}{\sqrt{2\pi kt}} \epsilon^{\frac{-x^2}{4kt}} \qquad (1)$$

where $\beta = \frac{x}{2\sqrt{kt}}$ and in which Θ is the temperature, x is the depth, k is the coefficient of thermal diffusivity, and t is the time since the earth was at the initial temperature of Θ_o, is unsatisfactory, because it necessitates assumptions which are not in accord with the facts. Consequently, this equation is more of hypothetical than of practical value. Kelvin's equation has considerable theoretical background, being the solution of the well-known Fourier equation for assumed limiting initial conditions. The equation, however, takes no account of internal heating which may arise from causes other than the original molten condition, such for example as those of radioactivity, chemical activity, and the like, which have been amply demonstrated as effects which can not be neglected. Furthermore, even when using a value for the earth's age which gives a geothermal gradient equal to known measurements, the computed temperatures have an almost linear relation to the depth for the first few miles, which is within the measured limits and the discussion in this note.

Butavand (Butavand, *Le Génie Civil*, May 10, 1919) and Lees (Lees, *Proc. Royal Soc.*, 83 A: 339, 1909) have proposed equations for the geothermal

temperature, but they were principally concerned with topographical configurations.

It is quite apparent that the ratio of the measured depths of the earth's crust to the earth's diameter is so small as to preclude any consideration of curvature. The sole question is one of the linear propagation of thermal disturbances in a heat-generating body, and the problem is concerned in the method of generation only to the extent of determining whether or not the heat liberated is a function of the temperature.

It is very easy to show that the rigorous differential equation for the linear propagation of thermal disturbances within a heat-generating body is given by

$$k\frac{d^2\vartheta}{dx^2} = c\varrho\frac{d\vartheta}{dt} + Q \qquad (2)$$

where k is the thermal conductivity, c is the specific heat capacity, and ϱ is the density of the material.

In the steady state in which $\frac{d\Theta}{dt} = 0$, this becomes

$$k\frac{d^2\vartheta}{dx^2} = Q \qquad (3)$$

Consider now a complex exothermic chemical reaction of the order

$$aA + bB + eE + \cdots \rightarrow \cdots \qquad (4)$$

in which case the velocity of the reaction is

$$\frac{dc}{dt} = K(C_a - C)^a(C_b - C)^b(C_e - C)^e \cdots \qquad (5)$$

where C is the concentration and K is the specific reaction rate. Since a differential change in concentration, dC, gives rise to the liberation of the differential quantity of heat, dH, consequently

$$\frac{dH}{dt} = Q = n\frac{dC}{dt} = nK(C_a - C)^a(C_b - C)^b \cdots \qquad (6)$$

If the reaction is essentially one of constant velocity, then

$$Q = mK \qquad (7)$$

where both m and n are proportionality constants.

Harcourt (Harcourt, *Phil. Trans. Roy. Soc.*, 212: 187, 1913) has shown that for a variety of chemical reactions the following relation holds between the specific reaction rate and the temperature:

$$K = p\vartheta^v \qquad (8)$$

where p is a proportionality constant and v is an exponent to be determined experimentally. Hence we have in the steady state

$$k\frac{d^2\vartheta}{dx^2} = mp\vartheta^v \qquad (9)$$

and finally, placing $u = \frac{mp}{k}$,

$$\frac{d^2\vartheta}{dx^2} = u\vartheta^v \qquad (10)$$

This differential equation expresses the temperature at any point perpendicular between two plane surfaces in chemically exothermic media after the steady state has been attained. By the use of the integrating factor, $2\frac{d\Theta}{dx}\,dx$, it can be reduced to the form

$$x = \frac{1}{\sqrt{v+1}}\int\frac{d\vartheta}{\sqrt{C_1(v+1) + 2u\vartheta^{(v+1)}}} + C_2 \qquad (11)$$

but, as far as the author is aware, no general solution of this integral can be given. It can, however, be integrated for certain values of v, such as $v = 1$ and $v = 3$ (Pierce, "A Short Table of Integrals," 1910, pp. 20, 34), but the value of v is an unknown quantity. When $v = 1$, the exponential equation

$$\vartheta = \vartheta_s\,\varepsilon^{ax} \qquad (12)$$

where Θ_s is the surface temperature, is a solution. When $v = 3$, the solution is a transcendental quadratic in Θ which can not be simply solved to give Θ as a function of x. The form of the solution, however, suggests that it would lead to a complicated exponential function. If $v = 0$, as would be the case if radioactive disintegration were the cause of heat liberation, since it has been fully demonstrated by Fajans (Fajans, "Radioactivity," 1922, p. 13), by Bronson (Bronson, *Proc. Roy. Soc.*, 78 A: 494, 1906), by Schmidt (Schmidt, *Phys. Zeit.*, 9: 113, 1908), by Curie and Onnes (Curie and Onnes, *Le Radium*, 10: 181, 1913), and by others that the phenomenon is independent of all physical conditions, high temperature included, the solution becomes a simple quadratic (Pierce, *op. cit.*, p. 16)

$$\vartheta = \vartheta_s + Ax + Bx^2 \qquad (13)$$

From measurements on the temperatures in deep wells made by Van Orstrand, Hallock and others (Darton, U. S. Geol. Survey Bul. 701, 1920) the constants of equation (12) and equation (13) can be computed as $a = 0.000146$, $A = 0.00828$, and $B = 0.000000816$.

Now it is very easy to show by equating coefficients that

$$B = \frac{Q}{2k} = 0.000000816. \qquad (14)$$

According to Joly (Joly, "Surface History of the Earth," 1925, p. 90) the average radioactive content of deep-seated basalts which have poured out of the continental surface amounts to about 1.0×10^{-12} grams of radium and 0.8×10^{-5} grams of thorium per gram of basalt. Assuming a mean density of 3.0, the average evolution of heat by radioactivity within the earth's crust amounts to approximately 0.33×10^{-12} gram calories per second per cubic centimeter of rock. In English units this is equivalent to $Q = 0.371 \times 10^{-10}$

B.t.u. per sec. per cu. ft., so that finally we have for the thermal conductivity of basalt, $k = 0.0000227$ B.t.u. per ft. cubed per deg. F. per sec., or in metric units $k = 0.00549$ gram cal. per cm cubed per deg. C. per sec., which agrees with the values of specific conductivity of granite, continental rock, basalt and sandstone, as quoted by Joly (*op cit.*, p. 72). That is to say, radioactivity alone *can* account for the known temperature of the earth's crust down to 8,000 feet.

Calculations of temperature in the earth's crust made with the two foregoing equations check exceedingly well, on the whole, with the temperature measurements that have been made by Van Orstrand, Hallock and others (Darton, *op. cit.*) on the world's deepest wells. Care must be exercised in applying the formulae to oil and Artesian wells, unless the depth of the source of flow be accurately known, for, if the seepage is from a greater depth than the bottom of the well, the temperature of the discharge will be far higher than the computed quantity. On the other hand, if the well taps a fissure short of the bottom, the temperature of discharge will be less than the computed value. Departures from the computed values may be attributed also to variations in the thermal conductivity of the rock. Of course the constants may be suitably modified for local conditions.

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A BLUE MUTATION IN THE RAT (MUS NORVEGICUS)

IN a genetic study of hypotrichosis or so-called hairlessness in rats two young in a litter of nine were found to be colored unlike any that had appeared before among more than 2,500 individuals. They were light yellowish or reddish gray in color, produced apparently by a dilution of the black.

All our stock went back on the paternal side to one "hairless" male captured at Farmington, Illinois, and on the maternal side to albino females from the Wistar Institute. The immediate father was unknown, though it was one of six males which together with the mother had been used by the division of physiological chemistry in some experiments with cystine and after being returned were held as stock animals. Only the one litter was produced, though the female was kept for twelve months after producing the litter with the unusually colored young.

Both these young were females and one died at five weeks of age. The other female was mated to both intense colored and albinos, intense colored progeny from both kinds of matings being produced as indicated in Table I.

TABLE I

MATINGS AND PROGENY OF DILUTE FEMALE

Mated to	Number of young	Color of young
Intense	8	Intense
Albinos	12	Intense

That this character is not in the color series is shown by the production of intense from matings with albinos.

Subsequent matings of heterozygous intense inter se, heterozygous intense with dilute, and dilute with dilute were made with results as given in Table II.

TABLE II

VARIOUS MATINGS INVOLVING DILUTION

Mating	Number of progeny	Color	
		Intense	Dilute
Dd* × Dd	52	36	16
Dd × dd	128	63	65
dd × dd	5		5

* d = dilution, D = allelomorph (intensity).

Agouti, non-agouti, hooded and non-hooded were other factors involved in these crosses, but results of these will be left for consideration after linkage studies are complete.

When agouti is absent the color of the mutant is very similar to the dilute black or "blue" of mice, rabbits, cats, dogs and *Mus rattus*. Dr. W. E. Castle mated a dilute gray male which I sent him to red-eyed yellow females of the formula rrCcHhaa. From these matings the following kinds were produced:

Gray self
Gray hooded
Black self
Black hooded
Albinos

The male was probably of the formula RRCcHhAa and homozygous for the new factor which tentatively is designated d. The red-eyed females would be homozygous for D.

Since this color had not previously appeared among some 2,500 descendants of the original stock, it appears probable that this is a recent mutation, though being a recessive it may have been carried some time before appearing.

In the light of the fact that it has not been reported, as far as I can discover, it is probably a new mutation in the rat, which causes a dilution of the black producing blues analogous to the so-called blues found in some other mammals.

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SCIENCE NEWS

Science Service, Washington, D. C.

TWIN CARBON

CARBON is the latest chemical element to be shown to have a twin. Last winter two California physicists showed that oxygen, long supposed to be single, was not only double, but triple. Now Dr. Arthur S. King, of the Mount Wilson Observatory, and Dr. Raymond T. Birge, of the University of California, have found a kind of carbon that is heavier than the ordinary form. Carbon is one of the most essential elements in living matter.

These experimenters heated carbon in a vacuum in an electric furnace to a temperature around 5,000 degrees Fahrenheit. When the light that is emitted was analyzed with a spectroscope, the usual bright bands of the spectrum appeared, including a very prominent red one. Close to this, however, the photographs showed another, very faint, and previously unknown.

Ordinary carbon is of mass 12, in the scale used for measuring the mass of the atoms. Dr. King and Dr. Birge announce that the new band can be explained by the presence along with ordinary carbon of another kind, or isotope, of mass 13. They are unable to estimate the relative proportions of the two kinds, but the heavier isotope must be present in very small quantities, for the band is hundreds of times as faint as the strong one.

Isotopes, or forms of the same element having different weight atoms, were first discovered in connection with studies of radium and similar elements. A few years ago Dr. F. W. Aston, of England, proved that a number of common elements consisted of as many as six or more isotopes. Last year Dr. W. F. Giauque and H. L. Johnstone, of the University of California, following up a lead given by Dr. King, showed the existence of three oxygen isotopes, weighing 17 and 18, as well as the ordinary kind, weighing 16.

EXPLORATION BY COLONEL LINDBERGH FOR LOST MAYA CITIES

WHEN Colonel Lindbergh and Carnegie Institution archeologists fly over the jungles of northern Central America and Mexico in search of lost Maya cities, they will be adding a new method to the scientific exploration of ruins of one of the world's most interesting civilizations.

Buried beneath almost impenetrable tropical forests in the Yucatan Peninsula, Guatemala, Honduras and British Honduras, there are the remains of populous cities that flourished long before the time of Columbus. Many of these abandoned cities, rich with artistic temples and monuments, lie hidden, unseen by modern eyes. On foot, tediously hacking a path through the tangled growth, an explorer might pass within a few hundred yards and yet not find the ruins. From the air, a few hours' flying may reveal not one, but several, hitherto unmapped and possibly totally unknown Maya cities.

Such is the expectation of Colonel Charles A. Lindbergh and of Dr. Oliver Ricketson, of the Carnegie Institution, who will fly with him in a Pan-American Airways airplane. Their base at Belize, British Honduras, is nearly in the center of the region that from before the time of Christ until about the year 1500 the Maya inhabited. To-day the descendants of the race that showed such accomplishments live in the same area in a primitive state, unmindful of their glorious past.

Colonel Lindbergh's aerial photographic experience obtained on recent flights over the southwest will prove useful on the projected flying over the Maya country. It is expected that he will act as photographer as well as pilot and that Dr. Ricketson will do the mapping that will allow land parties to reach and excavate the cities that are discovered.

The cooperation between the Pan-American Airways and the Carnegie Institution of Washington links two organizations that are pioneering in the rediscovery of Central America. The projected airlines of the Pan-American Airways pass near such cities as Chichen Itza, Copan and Etzna, which archeologists of the Carnegie Institution have excavated and studied.

The airplane in Middle America can duplicate the remarkable feats achieved in England, where O. G. S. Crawford, air corps observer, has discovered Roman towns and trenches by means of air photography. These trenches and streets were long since plowed over by British farmers and were presumably lost forever to the knowledge of historians, but where the ground was once disturbed, the texture of the soil has been altered, and the crops planted there are apt to be greener and more luxuriant. The air camera or the keen eye of the airplane observer can often trace the exact plan of the vanished town or fortress. By some such method the stone highways which the Maya built to connect their important cities can probably be traced.

It is only a few years ago that the existence of these smooth stone roads, 30 to 60 feet wide, was discovered. Dr. Thomas Gann, who found sections of the roads in the forest near Coba, concluded that the Mayas could not have needed such highways for traffic, since they had no wagons or beasts of burden and since they would have found dirt roads suitable for their long journeys. The roads, he believes, must have been laboriously constructed over long distances between religious centers for use by the religious processions of priests, votaries and sacrificial victims.

One highway for which search will be made is the road which Dr. Gann believes must have stretched from Coba to Cozumel Island to which the Maya made religious pilgrimages. Another may have led from Coba to Chichen Itza, famed religious city, sacred to the deity known as the Plumed Serpent.

The airplane archeologist has an opportunity to "discover" Middle America in pioneer fashion. The sixteenth century Spaniards who discovered Yucatan and the Aztec cities wrote excited, glittering accounts of gold and jewels and beautiful women and marble palaces. But their tales were considerably discounted by sober stay-at-homes, who

reflected that the Spaniards were not calm scientific observers and were merely trying to prove the importance and worth of their voyage of conquest.

Ninety years ago, an adventurous American, John L. Stephens, went into the Yucatan jungle and proceeded to discover the Indian cities again for the world at large. His verdict on the bas-reliefs and paintings which adorned the official buildings of the ruined cities was that "in justice of proportion and symmetry they have approached the Greek models."

After Stephens came a long series of archeologists, all of whom have been kept busy discovering the Mayas and the Aztecs. There are 1,200 sites in Mexico alone which are pronounced of archeological importance, and no one can guess how many more lie buried in inaccessible corners of the region.

The airplane offers a rapid method of discovering this much discovered country. More than that, it offers the possibility of revealing plans and explaining mysteries which could not be solved otherwise.

LIBERIAN RUBBER CLEARINGS

BOTANIZING over thousands of acres of tropical African treetops, a privilege unique in the history of plant collecting, is reported by G. Proctor Cooper, of Yale University, who has returned from the new Firestone rubber plantations in Liberia.

In order to make room for the great stretches of rubber seedlings, vast stretches of virgin jungle timber had to be felled. This laid the tops of the trees, where the best tropical botanizing is always to be had, literally at the collector's feet; and he has brought back one of the richest assemblages of tropical forest specimens that ever entered this country.

A principal object of Mr. Cooper's collecting was the timber itself. He has obtained logs of 130 species of trees, ranging all the way from the light and punky corkwood to the flinty red ironbark. These woods will be tested for strength and other properties in the Yale Forest School laboratory. In addition to the logs there are boards sawed out by hand, in the primitive native sawpits, and these will be tried out for their carpentry and furniture value.

So little is known in America about the flora of West Africa that arrangements have been made by Professor Samuel J. Record, who has charge of the tropical work at Yale University, to have the trees and other plants identified at the Royal Botanic Gardens at Kew, England. Duplicate sets of specimens have also been shipped to the Natural History Museum in London and the Imperial Institute at Oxford.

Collections were also made of birds and forest insects, mostly butterflies and beetles. Dried bark, leaves and fruits of 75 tree species used by native wizards and medicine-men will be studied by pharmaceutical chemists. Some of these plants, used as poisons by the natives, have properties still unknown to white men.

ORIGIN OF TROPICAL HURRICANES

TROPICAL hurricanes are long-distance travelers, for many of them originate a thousand miles east of the West Indies. The vicinity of the Cape Verde Islands, off the west coast of Africa, is one of their favorite breeding grounds, especially at this time of year.

These hurricanes all originate somewhere over the Atlantic Ocean in the tropics north of the equator. Calm air, high temperature and humidity are the most favorable conditions for the formation of a hurricane. Such conditions are most likely to be fulfilled in the "doldrums" of the North Atlantic in the late summer or early fall. Hurricanes may, however, occur at any time of year, or in other places. They also occur in the Pacific and Indian Oceans. Those of the southern hemisphere differ from those of the West Indies in one important way. The winds of the northern hurricanes spin in a direction opposite to the hands of a clock, while those in the southern ones spin clockwise.

As a result of the counter-clockwise spin of West Indian hurricanes, and the fact that they move westwards, their advent is always preceded by northerly winds, and followed by winds from the south.

Usually the Atlantic hurricanes travel northwesterly from their birthplace until they reach the region of the American coast, then they curve northwards, sometimes missing land completely, but menacing shipping along the north Atlantic coast.

One of the most famous of all tropical hurricanes was the one that devastated Galveston, Texas, in September, 1900. In September, 1926, Miami, Florida, was severely damaged. The hurricane that struck Palm Beach a year ago, causing the loss of hundreds of lives and $25,000,000 property damage, was of a similar type.

Though the autumnal equinox occurred on Monday, September 23, it is a mere coincidence that a number of these storms occur during September. The sun "crossing the line" does not make conditions any more favorable for them.

A NEW ANESTHETIC

A NEW anesthetic which puts patients to sleep so pleasantly and easily that they ask for more has been reported by Dr. J. S. Lundy, of the Mayo Clinic, and Dr. R. M. Isenberger, professor of pharmacology of the University of Kansas. Fewer unpleasant after-effects and far less danger than many of the local anesthetics are claimed for this new aid to surgery, which has the name of iso-amylethyl barbituric acid.

The work grew out of the old problem of how to offset the bad effects of some local anesthetics. Many investigators have sought means of avoiding the occasional cases of poisoning by cocaine. Accordingly, procaine, a synthetic product, was developed as a substitute for cocaine. However, bad reactions occasionally follow even the use of procaine. Drs. Isenberger and Lundy, following along the line of some previous workers, found that certain substitution products of barbituric acid gave protection against convulsions from procaine. They reported their work with iso-amylethyl barbituric acid about a year ago.

In the course of a year's further work, Dr. Lundy has used iso-amylethyl barbituric acid, experimentally, and for the benefit of patients, over a thousand times. He has given it by mouth before administering local anes-

thesia and the apprehension from which some patients suffer before an operation has been lessened in this way. Moreover, convulsions, that occasionally come on from the use of procaine, have not appeared in any cases in which iso-amylethyl barbituric acid has been used.

Also, following the work of Zerfas, Lundy has used this product, by injection into a vein, to produce all or part of the general anesthesia in 273 major operations. Surgeons who have employed it in this way have found that patients wish to have it again if, for any reason, they need to have another operation. It quiets patients before operation and adds to their comfort after operation by producing a semi-conscious state for some hours after they have returned to bed. Nausea and vomiting are greatly lessened or entirely eliminated.

More work must be done on this subject before the product will, or should be used as commonly as morphine, ether and nitrous oxide now are used in general anesthesia. For some time, as with any new procedure in medicine, cases in which the substance is to be used must continue to be carefully selected to eliminate risk. However, with the interest that has been aroused by this work, by the use of carbon dioxide at the end of inhalation anesthesia as advocated by Dr. Yandell Henderson, of Yale, and by the report on the use of cyclo-propane that was given recently by Dr. G. H. W. Lucas, of Philadelphia, and Dr. V. E. Henderson, of Toronto, at the Thirteenth International Physiological Congress, patients who must undergo operations may, in the near future, be freed from the dread that some of them have of being put to sleep.

ITEMS

MEAT and meat products are responsible for most food poisoning outbreaks, members of the American Public Health Association were told at their meeting in Minneapolis by Drs. Thomas G. Hull and Lloyd Arnold, of the Illinois State Department of Health and the University of Illinois College of Medicine. When much meat is eaten, the bacteria normally found in the small intestine, where meat is chiefly digested, are disturbed. The germ-killing action normally occurring in the small intestine is interfered with for six hours after a meat meal. Thus when germs are taken into the system with a meat meal, they have a good chance to develop and cause illness. Material containing a germ frequently implicated in food poisonings will produce irritations of stomach and intestines when it has been added to fresh meat, but no poisonous effect can be seen when the same material is added to a bread and milk diet.

TULAREMIA, newly discovered disease of rabbits, rodents and men, may also affect cats, muskrats, pigeons, ring-necked pheasants, grouse and quail, it appears from studies reported to the American Public Health Association by Dr. R. G. Green and E. M. Wade, of the University of Minnesota and the State Department of Health. This new disease which has caused much concern in public health circles, is acquired by men who handle infected animals. The fact that many more kinds of animals may have the disease greatly increases the danger to human beings by increasing the possible sources of infection.

RUSTPROOF steel is easily welded by the acetylene-oxygen process and is even more rustproof after welding than before due to loss of carbon, silicon and manganese during melting. These findings by W. Hoffman, German metallurgist, have just been announced by the National Advisory Committee for Aeronautics at Washington. The physical characteristics of rustproof-steel welds are better than those of soft-steel welds but the hardness of the metal due to welding must be removed by heat treatment. The rustproof steels most used contain large percentages of chromium or chromium and nickel.

PARIS GREEN, foe of potato beetles and other insect pests, promises victory in the war which California is waging against termites, sometimes called "white ants," destroyers of millions of dollars' worth of wood-built structures annually. The effectiveness of the Paris green dust depends first on the cleanliness of the termites. They are forever licking themselves clean, and thus swallow the deadly powder. After they have died or are very notably weakened, a second termite habit comes into play. The insects are cannibals through thrift; they eat up their deceased relatives. It does not matter if the dead termite met its end through poison; it gets eaten anyway. Thus the same dose of Paris green may do away with several termites in succession.

PEACEFUL passenger ships and fast cargo vessels now mount on their decks rangefinders such as heretofore have been seen only on ships of war. At the Shipping, Engineering and Machinery Exhibition at Olympia there were exhibited these new additions to navigation equipment capable of accurately determining the range of objects 500 to 25,000 yards distant. Modeled after the same type of instrument that has been used for army and navy purposes for the past forty years, the rangefinder on shipboard allows the navigator to locate immediately any ship, lighthouse or other object. An instrument with a base of 4 feet 9 inches will measure distance to within 76 feet at 2 sea miles and 608 feet at 6 sea miles.

MOVIES taken of sleepers indicate that the greatest possible relaxation occurs when the individual coils himself like a kitten and when he sprawls out like a swimmer. This new evidence on sleep is announced by Professor S. R. Hathaway, of Ohio University, and Dr. H. M. Johnson, of the Mellon Institute, who are conducting an investigation of sleep at the institute. Sleepers who took part in the experiment were blindfolded to avoid disturbance from light and were photographed in various poses by a motion picture camera. A typical subject took nine different poses in the course of about eight hours' sleep and shifted from one position to another 33 times. All the preferred positions required some supporting strain, and the experimenters discovered that about half the time is spent in postures which are mirror-images of others, thus resting the muscles that have been strained in previous poses.

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